****

NAVFAC **IGS-15601 (MAY 2002)**

Preparing Activity: LANTNAVFACENGCOM **Based on UFGS-15601N**

ITALIAN GUIDE SPECIFICATIONS

Use for ITALIAN projects only

****

SECTION 15601

CENTRAL REFRIGERATION EQUIPMENT FOR AIR CONDITIONING

05/02

****

NOTE: This guide specification is issued by the Atlantic Division, Naval Facilities Engineering Command for regional use in Italy.

****

****

NOTE: This guide specification covers central refrigeration equipment for built-up air-conditioning systems.

****

****

NOTE: The following information shall be shown on the projects drawings:

1. Indicate size and locations of cooling tower supports.

2. Locations of water treatment tanks and control panels.

3. Indicate size and routing of refrigerant safety relief discharge piping. Consult ASHRAE 15 "Safety Code for Mechanical Refrigeration."

4. Indicate a cooling tower basin heating system for cooling towers that will be required to operate when outside temperatures are below freezing and the heat generated through the refrigeration process (with head pressures maintained) will be insufficient to preclude freeze-ups. Either electric immersion heaters or steam or hot water coils may be used for supplemental heating.

****

****

Comments and suggestion on this specification are welcome and should be directed to the technical

proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

****

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AIR-CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 740	(1998) Refrigerant Recovery/Recycling Equipment

AMERICAN SOCIETY OF HEATING, REFRIGERATING, AND AIR-CONDITIONING ENGINEERS, INC. (ASHRAE)

ASHRAE 15	(1994; Errata 1994) Safety Code for Mechanical Refrigeration

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME BPVC SEC VIII	(1995; Addenda 1995, 1996, and 1997) Boiler and Pressure Vessel Code: Section VIII Pressure Vessels
ASME BPV VIII Div 1	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME BPV IX	(1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

ITALIAN ELECTROTECHNICAL COMMITTEE (CEI)

****

NOTE: A CEI Norm is an Italian technical normative for electrical systems recognized by Italian Law, submitted by a private organization "Comitato Electrotecnico Italiano" for the Italian territory, available in the Italian language and only in some cases in English.

****

CEI 64-8	(1998) Electrical installations of buildings

ITALIAN LAWS AND NORMS (D.M.)(LAW)(CIRC.)

****

NOTE: Italian laws and normatives are the legislative regulations and decrees issued by the Italian government in the form of laws, norms, decrees, circulars, and letters. These Laws and Decrees concur together with Norms and Standards in forming the governing directives for construction.

****

C.M. 35	24/03/73, Units for Air Conditioning, Clarifications for the Norm Application Circ. 68 of 25 November 1969 and n. 43 of 29 July, 1971
D.P.R. 236	24/05/88, Implementation of the Instruction CEE n. 80/778 Regarding the Quality of Water for Human Consumption, in Accordance with Art. 15 of Law 16 April 1987, n. 183
D.L. 475	4/12/92, Implementation of the Instructions 89/686/CEE Regarding the Legislations of the Member Countries Related to Individual Protection
D.P.R. 412	26/08/93, Norms Regulation for the Design, the Installation, the Operation and Maintenance of Thermal Plants in Buildings for Energy Conservation in Accordance with Art. 4 of Law 9/01/91 n. 10
D.L. 22	5/02/97, Implementation of the Instructions 91/56/CEE Concerning Hazardous Wastes 91/689/CEE and 94/62/CEE Concerning Packaging of Wastes
D.L. 372	4/08/99, Implementation of Instructions 96/61/CE Regarding Prevention and Integrated Reduction of Pollution

ITALIAN NATIONAL ASSOCIATION FOR UNIFICATION OF STANDARDS (UNI)

****

NOTE: A UNI Norm is a technical normative recognized as Italian Law, submitted by a private organization "Ente Nazionale Italiano di Unificazione" for Italy and is available only in

the Italian language. It is the National Standard.

****

UNI 5339	(1969) Pipes, fittings and special castings for gray cast iron pressure main lines - Centrifugally or vertically sand cast socket and spigot pipes - Class A
UNI 6346	(1968) Bronze and brass castings - Deviations in dimensions without tolerance indication
UNI 7181	(1973) Steel formed heads for welded pressure vessels and boiler drums - Without manhole type
UNI 7182	(1973) Steel formed heads for welded pressure vessels and boiler drums - With centre manhole type
UNI 7183	(1973) Steel formed heads for welded pressure vessels and boiler drums - With eccentric manhole type
UNI 8011/FA 108	(1979/82) Refrigerating plants - Safety requirements
UNI 8724	(1985) Water-cooled refrigerant condensers - Test methods
UNI 8774/FA-1	(1985/89) Cooling towers - Testing

ITALIAN/EUROPEAN HARMONIZATION STANDARDS (UNI EN)(UNI ENV)(CEI EN) (UNI EN ISO)(UNI ISO)

****

NOTE: A UNI EN, UNI ENV, CEI EN, UNI EN ISO or UNI ISO is a European Standard with a coincident Italian National Standard or International Standard. The two standards are identical, with most (but not all) EN's available in the English language and the UNI available only in the Italian language.

****

UNI EN 255-3	(1998) Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors - Heating mode - Part 3: Testing and requirements for marking for sanitary hot water units
UNI EN 761	(1996) Plastics piping systems - Glass-reinforced thermosetting plastics (GRP) pipes - Determination of the creep

	factor under dry conditions
UNI EN 1092-2	(1999) Flanges and their joints - Circular flanges for pipes, valves, fittings and accessories, PN designated - Part 2: Cast iron flanges
UNI EN ISO 3744	(1997) Acoustics - Determination of sound power levels of noise sources using sound pressure - Engineering method in an essentially free field over a reflecting plane
UNI ISO 9227	(1993) Corrosion tests in artificial atmospheres - Salt spray tests
UNI EN 10020	(2001) Definition and classification of grades of steel
UNI EN 10240	(1999) Internal and/or external protective coatings for steel tubes - Specification for hot dip galvanized coatings applied in automatic plants
UNI EN 12055	(2002) Liquid chilling packages and heat pumps with electrically driven compressors - Cooling mode - Definitions, testing and requirements
CEI EN 60034-1	(1996) Rotating electric machines - Part 1: Rating and performance
CEI EN 60947-4-1	(1998) Low-voltage switchgear and controlgear - Part 4: Contactors and motor-starters - Section 1 - Electromechanical contactors and motor-starters

1.2 RELATED REQUIREMENTS

Section 15050, "Basic Mechanical Materials and Methods," applies to this section with the additions and modifications specified herein.

1.4 SUBMITTALS

****

NOTE:

Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item is required.

A "G" following a submittal item indicates that the

submittal requires Government approval. Some submittals are already marked with a “G”. Only delete an existing “G” if the submittal item is not complex and can be reviewed through the Contractor’s Quality Control system. Only add a “G” if the submittal is sufficiently important or complex in context of the project.
For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Recommended codes for Army projects are "RE" for Resident Engineer approval, "ED" for Engineering approval, and "AE" for Architect-Engineer approval. Codes following the "G" typically are not used for Navy projects.
Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy projects.

****

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-02 Shop Drawings

Water chillers

Air-cooled condensers, remote-type

Cooling towers, including supporting members

Accessories

SD-03 Product Data

Water chillers

Compressor units

Air-cooled condensers, remote-type

Water-cooled condensers, remote-type

Cooling towers

Cooling tower water treatment systems, including chemicals

Electric motors and starters

Accessories

SD-06 Test Reports

Salt-spray tests

Start-up and initial operational tests

Water analysis

Field-assembled cooling towers performance tests

SD-07 Certificates

Cooling towers

Submit certification that performance of cooling towers will meet contract requirements, stating ambient air wet bulb temperatures, entering and leaving water temperatures, water flow rate, fan power, and pump head at base of towers. Submit certification and curves showing predicted performance.

SD-08 Manufacturer's Instructions

Central refrigeration equipment

Cooling tower water treatment systems

Chemicals

Submit an Occupational Safety and Health Act (OSHA) Material Safety Data Sheet for chemicals provided.

SD-10 Operation and Maintenance Data

Water Chillers, Data Package 3

Compressor units, Data Package 3

Air-cooled condensers, remote-type, Data Package 3

Water-cooled condensers, remote-type, Data Package 3

Cooling towers, Data Package 3

Cooling tower water treatment systems, Data Package 3

Electric motors and starters, Data Package 3

Submit operation and maintenance data in accordance with Section 01781, "Operation and Maintenance Data."

SD-11 Closeout Submittals

Central refrigeration equipment

Submit text.

1.5 QUALITY ASSURANCE

1.5.1 Modifications of References

In the referenced publications, the advisory provisions shall be mandatory; substitute the word "shall" for "should" or "it is recommended" wherever they appear; reference to the "authority having jurisdiction" and "owner" shall be interpreted to mean the Contracting Officer.

1.5.2 Pressure Vessels

Design, fabrication, inspection, and testing of pressure vessels including waterside and refrigerant side of condensers and liquid coolers (evaporators) shall be in accordance with ASME BPVC SEC VIII, UNI 7181, UNI 7182, and UNI 7183.

1.5.3 Personnel Protection

D.L. 475. Provide personnel protection from moving parts including fans, pulleys, chains, gears, and couplings. High temperature machinery and piping shall be guarded or covered with insulation.

1.5.4 Electrical Systems

Wiring and components shall conform to CEI 64-8.

1.6 CENTRAL REFRIGERATION EQUIPMENT

Provide manufacturer's instruction, including evacuation and charging procedures.and posted operating instructions for each piece of refrigeration equipment.

1.7 REFRIGERANTS AND OILS

Dehydrate, purge, and charge refrigerant circuit with refrigerant and oil at factory. Factory oil and refrigerant charge shall be full amount required for operation; otherwise, a holding charge shall be furnished. Field charging, where only a holding charge is shipped, shall be accomplished without breaking permanent refrigerant connections. Furnish one complete charge of lubricating oil in sealed containers in addition to that placed in system. Chillers using R-11, R-12, R-113, R-114, R-115, or R-500 as a refrigerant will not be permitted. Refrigerants shall be in accordance with D.L. 372 and have an Ozone Depletion Factor (ODF) of 0.05 or less. The ODF shall be in accordance with the "Montreal Protocol On Substances That Deplete The Ozone Layer," September 1987, sponsored by the United Nations Environment Programme.

1.8 COOLING TOWER WATER TREATMENT SYSTEM

Provide a water treatment system for the cooling tower system as indicated on the drawings and specified herein.

1.8.1 Supplier

The water treatment chemical and service supplier shall be a recognized specialist whose major business is in the field of water treatment. The supplier shall have been active in the field of industrial water treatment for at least five years and shall have a fully staffed laboratory, development facility, service department, full-time technical service representatives and area backup personnel.

1.8.2 Chemicals

Provide, at no additional cost to the Owner, all chemicals required for treating and and testing included water systems for one year of operation. The appropriate chemicals to be used will be determined by the analysis of a water sample taken from the building site by the water treatment supplier. Provide ingredients necessary to achieve the desired water conditions.

1.8.3 Instructions

Instruct Owner's personnel in the use and operation of each water treatment system, including: Monitoring equipment, feed equipment, preparation of chemical solutions, charging of the chemical solution reservoirs, proper handling of chemicals, and proper use of test kits, charts and logs. Furnish water test equipment and reagents in appropriate cases to verify control parameters.

PART 2 PRODUCTS

2.2 SOURCE MANUFACTURERS

2.2.1 Self-Contained Water Chillers

The following manufacturers provide self-contained water chillers that generally comply with these specifications:

CARRIER
Matozzo Franco
Via Lucrezia Romana, 65N
00043 Ciampino - Roma
Tel: 06/7922821
Fax: 06/7922827

CLIVET S.p.a.
Via Camp Lonc, 25 - Zona Industriale
32030 Villapaiera di Feltre (BL) - Italy
Tel: 39-0439-3131
Fax 39-0439-313300

DELCHI
20058 Villasanta - Milano
Via Raffaello Sanzio, 9
Tel: 039.36.36.1

MTA S.r.l.
Via Artigianato, 2
35026 Conseive (PD) - Italy
Tel: 39-0-499597211
Fax: 39-0-499500620

RIELLO S.p.A.
37045 Legnago (VR)
Tel: 0442630111
Fax: 044222378

TRANE (Italy)
Via Enrico Fermi 21/33
20090 Assago (Milano)
Tel: 02.457951
Fax: 02.4880170

YORK
Via Santa Maria in Campo, 1/A
20040 Cavenago di Brianza - Milano
Tel: 02.95335330
Fax: 02.95335336

2.2.2 Cooling Towers

The following manufacturers provide cooling towers that generally comply with these specifications:

CLIVET S.p.a.
Via Camp Lonc, 25 - Zona Industriale
32030 Villapaiera di Feltre (BL) - Italy
Tel: 39-0439-3131
Fax 39-0439-313300

COFIN S.p.A.
00146 - Roma
Tel: 06/55.87.641
Tel: 06/55/34.011
Fax: 06/55.93.012

MTA S.r.l.
Via Artigianato, 2
35026 Conseive (PD) - Italy
Tel: 39-0-499597211
Fax: 39-0-499500620

2.2 SELF-CONTAINED WATER CHILLERS

Provide complete, packaged water chillers, each mounted on a single welded-steel base. Chillers shall be ready for operation after installation and field testing. Equipment shall operate within capacity range and speed recommended by the manufacturer. Parts weighing 23 kg or more which must be removed for inspection, cleaning, or repair, such as motors, gear boxes, cylinder heads, casing tops, condenser, and cooler

heads, shall have lifting eyes or lugs. Provide insulation for surfaces subject to sweating including the liquid cooler, suction line piping, water boxes, economizer, and cooling lines. Insulation shall conform to Section 15080, "Mechanical Insulation."

2.2.1 Centrifugal, Helical Rotary, Water-Cooled

****

NOTE: Specify applicable ratio after consulting current literature to ensure an energy-efficient system is provided. The ratios specified shall permit unlimited competition among at least three manufacturers.

****

Base capacity and power ratings, at the conditions indicated and specified, on the test requirements of UNI EN 255-3. Power input shall not exceed [_____] kW/kW load at full load capacity.

2.2.1.1 Centrifugal Compressors

Statically and dynamically balanced impellers, either direct or gear driven by an electric motor. Impeller shafts shall be heat-treated alloy steel. Shaft main bearings shall be journal type with bronze or babitted liners or aluminum-alloy, one-piece insert type, or rolling element bearings with an Anti-Friction Bearing Manufacturers Association L10 life greater than 200,000 hours. Casings of cast iron, aluminum, or steel plate shall have split sections with gaskets which are bolted or clamped together. Lubrication systems shall be forced-feed type. An oil pressure differential cutout interlocked with the compressor starter shall allow compressor to operate only when required oil pressure is provided. Provide for lubrication of bearings and shaft seals prior to starting and on stopping with or without electrical power supply. Speed reducing gears shall be designed to ensure self-alignment, interchangeable parts, proper lubrication and minimum of unbalanced forces. Gear box bearings shall be sleeve type. Provide pressure lubrication with pump and cooler. Gear cases shall be oiltight. Shaft extensions shall be provided with seals to retain oil and exclude dust. Compressors shall operate stably and for indefinite periods of time at any stage of capacity reduction from 100 to 10 percent of full load capacity.

2.2.1.2 Helical Rotary Compressors

Positive displacement, oil-injected type, and driven by an electric motor. Rotors shall be solid steel, Society of Automotive Engineers Grade 1141 or 1144. Shaft main bearings shall be either sleeve-design type with leaded bronze or steel-backed babbit; or frictionless bearing design, ball or roller type. Housings and covers shall be high-grade, cast iron or aluminum pressure castings. Lubrication systems shall lubricate rotors, bearings, shaft seal as well as rotor sealing and cooling. Provide an oil safety cutout interlocked with the compressor starter to allow compressor to operate only when oil system is operational. Provide for lubrication of bearings and shaft seals on shutdown with or without electrical power supply. Compressors shall operate stably and for indefinite periods of

time at any stage of capacity reduction from 100 to 10 percent of full load capacity.

2.2.1.3 Condensers

****

NOTE: The selection of the double-tube bundle is a design function where a steady demand exists for low grade rejected heat. Where this demand does not exist or where the heat recovery cannot be justified, the single-tube bundle should be used. When marine water boxes are requested by the activity, use the second bracketed sentence and delete the first bracketed sentence. If not requested, use the first bracketed sentence and delete the second bracketed sentence.

****

[Shell-and-tube construction shall permit tubes to be cleaned from each end by removing water box cover plates or head and minimum amount of water piping.] [Shell-and-tube construction with water boxes having side mounted piping connections and cover plates to permit tubes to be cleaned from each end without removing connected piping.] Refrigerant side design pressure shall comply with C.M. 35. Water side design pressure shall not be less than 1034 kPa (gage). Tubes shall be fabricated of seamless copper tubing, with plan or integral fins and shall be individually replaceable and rolled or brazed into copper or steel tube sheets. Base performance on a water velocity not less than 0.91 meter per second (m/s) nor more than 3.66 m/s and a fouling factor of 0.00075. Condensers shall be [single] [double]-tube bundle type.

2.2.1.4 Liquid Coolers (Evaporators)

Removable copper tube, bundle type constructed of seamless copper tubing rolled or brazed into copper or steel tube sheets with baffles and tube supports of copper; or liquid cooler shall be fabricated of seamless copper tubing, plain or with integral fins, individually replaceable and rolled or brazed into copper or steel tube sheets with tube supports of copper or steel plate. Refrigerant side design pressure shall comply with C.M. 35. Water side design pressure shall not be less than 1034 kPa (gage). Liquid cooler feed control shall feed liquid cooler at all levels of capacity from 100 percent down to minimum required operating level. Base performance on a water side velocity not less than 0.91 m/s nor more than 3.66 m/s, and fouling factor of 0.00025.

2.2.1.5 Purge Systems

If chiller operates at refrigerant pressures below 101.34 kpa(gage), provide a purge system and connect to main refrigeration system. Purge systems shall automatically remove air, water vapor, and noncondensable gases from refrigeration system and condense, separate, and return to system refrigerant present. Provide an oil separator, if required by manufacturer. Purge systems shall provide a warning to signal operator at occurrence of excessive purging, indicating abnormal air leakage into unit.

Purge systems shall not discharge to occupied areas, or create a potential hazard to personnel.

2.2.1.6 Evacuation or Pump-Out Systems

When a positive refrigerant is used and basic chiller unit will not permit pumpdown storage and isolation of entire charge within basic unit, provide a manually started and stopped evacuation or pump-out system, consisting of a condensing unit and a receiver of sufficient capacity to store entire refrigerant charge of largest water-chilling system or unit. When designed to permit pumpdown of entire refrigerant charge and isolation of entire refrigerant charge within basic unit, a separate evacuation or pump-out shall not be required. Receivers shall be provided with rupture members and dual relief valves, piping, and controls so that the evacuation or pump-out system may be provided without temporary piping or wiring.

2.2.1.7 Controls, Control Panels, and Gages

****
NOTE: Specify required time delay for type and size of unit after consulting current literature.
****

****
NOTE: Include sentence in brackets if centrifugal chillers are specified.
****

Provide an automatic capacity-reduction system for stable operation from 100 to 10 percent of full load capacity. Provide modulating, chilled-water controls with adjustable throttling range, a means of calibration, and a means of adjusting chilled-water temperature control point. Provide a time delay of not less than [_____] minutes to prevent compressor restart when a compressor is shut down by the operating controls. Provide a demand limiter to minimize amperage draw. [Provide controls to restart chiller automatically if power is interrupted for three seconds or less.] Provide a control panel complete with compressor operating control, start-stop switch, and the following gages and protective devices:

a. Gages:

(1) Evaporator pressure

(2) Condenser pressure

(3) Oil pump pressure

(4) Elapsed running time meter

b. Protection Devices With Manual Reset:

(1) Low oil temperature lockout

(2) Low refrigerant temperature cutout

(3) Low temperature chilled-water or refrigerant cutout

(4) High-pressure cutout

(5) Low oil pressure cutout or low oil flow cutout

(6) High oil or bearing temperature cutout

(7) High motor winding temperature cutout

(8) Compressor motor overload cutout

(9) Low chilled water flow cutout

(10) Low condenser water flow cutout

2.2.1.8 Signal Lights

Provide signal lights or other visual "failed" indications for specified protective devices. Provide a minimum 100 mm alarm bell and alarm circuit to actuate the bell in event of machine cutout on protective devices except when low pressure cutout is used as an operating control.

2.2.1.9 Electric Motors and Starters

Provide polyphase, induction electric motors conforming to CEI EN 60034-1. Provide motors suitable for use with the indicated electrical power characteristics and the type of starter provided. Provide reduced voltage, closed-transition type motor starter conforming to CEI EN 60947-4-1. Provide phase failure, phase reversal, over voltage and under voltage protection.

2.2.2 Reciprocating, Helical Rotary, Scroll, Air-Cooled

****

NOTE: Specify applicable ratio after consulting current literature to ensure an energy-efficient system is provided. The ratios specified shall permit unlimited competition among at least three manufacturers.

****

Base capacity and power ratings, at the conditions indicated and specified, on the test requirements of UNI EN 255-3. Power input shall not exceed [_____] kW/kW load at full load capacity. For multicompressor units, not less than two independent refrigerant circuits shall be provided. Chillers shall be capable of operating at partial-load conditions without increased vibration over normal vibration at full load operation, and shall be capable of continuous operation down to minimum capacity.

2.2.2.1 Casings

Aluminum not less than one mm in nominal thickness or steel not lighter

than 1.31 mm in nominal thickness. Provide condensers having horizontal air discharge with discharge baffles to direct air upward, constructed of same material and thickness as casing. Provide wire screens or louvers over exposed condenser coil fins not protected by casing.

2.2.2.2 Reciprocating Compressors

Provide with forced-feed lubrication, crankcase heater, hot-gas muffler and suction strainer. Cylinder unloading devices shall be unloaded when compressor starts. Piston speed for open compressors shall not exceed recommendations of manufacturer or 5.1 m/s, whichever is less.

2.2.2.3 Helical Rotary Compressors

Positive displacement, oil injected type, and driven by an electric motor. Rotors shall be solid steel, Society of Automotive Engineers Grade 1141 or 1144. Shaft main bearings shall be either sleeve-design type with leaded bronze or steel-backed babbit; or frictionless bearing design, ball or roller type. Housings and covers shall be high-grade cast-iron pressure castings. Lubrication systems shall lubricate rotors, bearings, shaft seal as well as rotor sealing and cooling. Provide an oil safety cutout interlocked with the compressor starter to allow compressor to operate only when oil management system is operational. Provide for lubrication of bearings and shaft seals on shutdown with or without electric power supply.

2.2.2.4 Scroll Compressors

Three-dimensional, compliant, hermetically sealed design. Compressors shall be mounted on vibration isolators. Rotating parts shall be factory balanced. Main bearings shall be rolling-element type. Lubrication systems shall be centrifugal pump type including oil level sight glass and oil charging valve.

2.2.2.5 Condenser Coils

****

NOTE: Research project location conditions to determine the environmental effects on finned tube coils. The research should include a survey of existing similar equipment. Prepare project specifications based on the conclusions of the research. Consideration should be given to the following combinations based on past experience of these materials in dealing with the local conditions.

1. Copper tube and aluminum fins, coated

2. Copper tube and copper fins, coated

3. Aluminum tube and aluminum fins, coated

4. Aluminum tube and aluminum fins, uncoated

5. Copper tube and copper fins, uncoated

6. Copper tube and aluminum fins, uncoated.

****

Extended-surface fin-and-tube type. Condenser coils shall be constructed of [copper tubes and aluminum fins] [copper tubes and copper fins] [aluminum tubes and aluminum fins]. Fins shall be hydraulically or mechanically bonded to tubes and installed in a metal casing. Coils shall be circuited and sized for a minimum of minus 15 degrees C subcooling and full pumpdown capacity. [Provide a coating as specified in the paragraph entitled "Coatings for Finned Tube Coils." Coils to be coated shall be part of the manufacturer's standard product for the capacities and ratings indicated and specified. Fins shall be plate type.]

2.2.2.6 Fans

Statically and dynamically balanced. For V-belt drive fans, provide adjustable sheaves. Provide fans with vibration isolation devices to minimize vibration transmission.

2.2.2.7 Liquid Coolers (Evaporators)

****

NOTE: Insert winter design temperature that the equipment will be subjected to.

****

Tubes shall be seamless copper. Refrigerant side design pressure shall comply with C.M. 35. Water side design pressure shall not be less than 1034 kPa (gage). On direct-expansion units, each refrigerant circuit shall be complete with liquid solenoid valve and expansion device capable of modulating to minimum capacity. For the water side of liquid cooler, the performance shall be based on a water velocity ranging from 0.91 to 3.66 m/s with a fouling factor of 0.00025. Cooler shall be provided with an electrical heating cable for freeze-up protection to [____] degrees C ambient.

2.2.2.8 Controls, Control Panels, and Gages

****

NOTE: Specify required time delay for type and size of unit after consulting current literature.

****

****

NOTE: Specify lowest percent of full capacity required. Check for availability before inserting number in blank.

****

****

NOTE: Insert winter design temperature that the equipment will be subjected to.

****

CEI 64-8. Provide a control panel fitted with a discharge pressure gage, suction pressure gage, separate high pressure cutout with manual reset, separate low pressure cutout, low water temperature cutout with manual reset, compressor operating control, and manual off-auto switch. Provide oil pressure gage and low-oil-pressure cutout switch with manual reset for chillers with positive displacement type oil pumps. Provide signal lights or other visual "failed" indications for high pressure, low pressure, and oil pressure protection devices. Multicompressor units shall be provided with a lead/lag selector switch. Provide a timer to prevent compressors from short cycling whenever stopped by safety controls. Time delay shall be not less than [_____] minutes. A pumpdown cycle of the nonrecycling start type shall be provided for each compressor 70 kW or larger. Provide a minimum 100 mm alarm bell and alarm bell circuit to actuate bell in event of machine cutout on protective devices, except when low-pressure cutout is used as an operating control. Provide system capacity control to adjust chiller output to a minimum of [_____] percent of full load capacity without cycling operating compressor and to automatically recycle system on power interruption. Provide start-up and head pressure controls to allow for system operation at all ambient temperatures down to [_____] degrees C.

2.2.2.9 Electric Motors and Starters

Provide induction electrical motors conforming to CEI EN 60034-1. Fan motor bearings shall be permanently lubricated. Compressor starters shall be [across-the-line magnetic] [reduced-voltage] type conforming with CEI EN 60947-4-1. Provide phase failure, over voltage and low voltage protection.

2.2.3 Reciprocating, Helical Rotary, Scroll, Water-Cooled

****

NOTE: Specify applicable ratio after consulting current literature to ensure an energy-efficient system is provided. The ratios specified shall permit unlimited competition among at least three manufacturers.

****

UNI 8724. Base capacity and power ratings, at the conditions indicated and specified, on the test requirements of UNI 8724. Power input shall not exceed [_____] kW/kW load at full load capacity. For multicompressor units, not less than two independent refrigerant circuits shall be provided. Chillers shall operate at partial-load conditions without increased vibration over normal vibration at full-load, and shall be capable of continuous operation down to minimum capacity.

2.2.3.1 Reciprocating Compressors

Provide with forced-feed lubrication, crankcase heater, hot-gas muffler, and suction strainer. Cylinder unloading devices shall be unloaded when compressor starts. Piston speed for open compressor shall not exceed recommendations of manufacturer or 5 m/s, whichever is less.

2.2.3.2 Helical Rotary Compressors

Shall be positive displacement, oil-injected type, and driven by an electric motor. Rotors shall be solid steel, Society of Automotive Engineers Grade 1141 or 1144. Shaft main bearings shall be either sleeve-design type with leaded bronze or steel-backed babbit; or frictionless bearing design, ball or roller type. Housings and covers shall be high-grade, cast-iron or aluminum pressure castings. Lubrication system shall lubricate rotors, bearings, shaft seal as well as rotor sealing and cooling. Provide an oil safety cutout interlocked with the compressor starter to allow compressor to operate only when the oil system is operational. Provide for lubrication of bearings and shaft seals on shutdown with or without electrical power supply.

2.2.3.3 Scroll Compressors

Three-dimensional, compliant, hermetically sealed design. Compressors shall be mounted on vibration isolators. Rotating parts shall be factory balanced. Main bearings shall be rolling-element type. Lubrication systems shall be centrifugal pump type including oil level sight glass and oil charging valve.

2.2.3.4 Condensers

****

NOTE: The selection of the double-tube bundle is a design function where a steady demand exists for low grade rejected heat. Where this demand does not exist or where the heat recovery cannot be justified, the single-tube bundle should be used.

****

Water-cooled condensers shall have shell-and-tube construction, permitting tubes to be cleaned from each end by removing water box cover plates or head and a minimum amount of water piping. Refrigerant side design pressure shall comply with C.M. 35. Water side design pressure shall not be less than 1034 kPa (gage). Tubes shall be fabricated of seamless copper tubing, plan or with integral fins, and shall be individually replaceable and rolled or brazed into copper or steel tube sheets. Base performance on a water velocity not less than 0.91 m/s nor more than 3.66 m/s and a fouling factor of 0.00075. Condenser shall be [single] [double]-tube bundle type.

2.2.3.5 Liquid Coolers (Evaporators)

Tubes shall be seamless copper. On direct-expansion-type units, each refrigerant circuit shall be complete with liquid solenoid valve and expansion device capable of modulating to minimum capacity. For the water side of liquid cooler, performance shall be based on a water velocity not less than 0.91 m/s nor more than 3.66 m/s and a fouling factor of 0.00025.

2.2.3.6 Controls, Control Panels, and Gages

****

NOTE: Specify required time delay for type and size

of unit after consulting current literature.
****

****
NOTE: Specify lowest percent of full capacity required. Check for availability before inserting number in blank.
****

Provide a control panel fitted with a discharge pressure gage, suction pressure gage, separate high pressure cutout with manual reset, separate low pressure cutout, low water temperature cutout with manual reset, compressor operating control, and manual off-auto switch. Provide oil pressure gage and low-oil-pressure cutout switch with manual reset for chillers with positive displacement type oil pumps. Provide signal lights or other visual "failed" indications for high pressure, low pressure, and oil pressure protection devices. Multicompressor units shall be provided with a lead/lag selector switch. Provide a timer to prevent compressors from short cycling whenever stopped by safety controls. Time delay shall be not less than [_____] minutes. A pumpdown cycle of the nonrecycling start type shall be provided for each compressor 70 kW or larger. Provide a minimum 100 mm alarm bell and alarm bell circuit to actuate bell in event of machine cutout on protective devices, except when low-pressure cutout is used as an operating control. Provide system capacity control to adjust chiller output to a minimum of [_____] percent of full load capacity without cycling operating compressor and to automatically recycle system on power interruption. Provide start-up and head pressure controls to allow for system operation at all ambient temperatures down to [_____] degrees C.

2.2.3.7 Motors and Starters

Provide [across-the-line magnetic] [reduced voltage] type motor starters conforming with CEI 64-8. Provide phase failure, over voltage and low voltage protection. Provide induction electric motors conforming with CEI EN 60034-1.

2.2.4 Absorption Chillers[/Heaters]

Absorption chiller[/heater] shall be designed, constructed, tested, and rated in accordance with UNI 8724 and shall meet the requirements of UNI EN 255-3. Unit shall be capable of operating automatically and continuously between 10 percent and 100 percent of full load. Unit shall include:

1. Absorber

2. Condenser

3. Evaporator

4. Generator - low stage generator for single-effect units and low and high stage generator for double-effect units

5. Solution heat exchangers

6. Pumps for solution and refrigeration recirculation

7. Controls

    a. Low temperature cut-out

    b. Provisions for interlocks to prevent or stop operation of the chiller package upon failure of chilled water flow

    c. Means for electrically protecting pump motors included in the package against thermal overload

    d. Chilled water[/heating] temperature controller

    e. Instrument panel

    [f. Burner controls and [gas] [oil] train safeties per UNI 8011/FA 108]

8. Anticrystallization or automatic decrystallization equipment

9. Miscellaneous

    a. Absorbent charge

    b. Means for removing non-condensables from the chiller

    c. Interconnecting piping, base and supports

    d. Installations and operating instructions

    e. Nameplate

2.2.4.1 Capacity Criteria

****

NOTE: The following is a list of appropriate minimum full load ratings to be used for units covered by UNI 8724. These values or higher values will be entered into the specification where indicated, and placed on the drawings. The designer should contact manufacturers to determine what is available before specifying values.

	Full Load COP	**Heating Efficiency**
Direct Fired, Double Effect	**0.97**	**80 percent**
Indirect Fired, Single Effect	**0.65**	
Indirect Fired, Double Effect	**1.20**	

****

Unit shall have a minimum Coefficient of Performance (COP) of [_____] at

full load rating in accordance with UNI 8724. Unit shall have a minimum [Integrated Part Load Value (IPLV)] [Application Part Load Value (APLV)] of [_____] COP in accordance with UNI 8724.

2.2.4.2 Absorber, Evaporator, Condenser, & Generator

****

NOTE: Although a double effect absorption water chiller[/heater] costs more, than a single effect absorption water chiller an engineering economic study made in accordance with Life Cycle Costing technique may indicate substantial savings in energy, resulting in the lower cost alternative over the projected useful life of the facility. When this determination is made, the item within the brackets will be used, provided the cost of the project can be kept within the alloted funds. The use of double effect absorption will be considered if high pressure steam (or hot water) is available. No new heat generating plant will be constructed to serve the double effect units; this restriction is the same as currently in effect for ordinary absorption units. If steam or hot water is not available, a direct fired absorption chiller[/heater] may be installed. If hot water is required, a Life Cycle Cost analysis shall be performed to determine if a direct fired absorption chiller/heater is more economical than a separate chiller and boiler. The inapplicable pressure depending, upon steam or hot water, will be deleted.

****

The absorber, evaporator, condenser, and generator shall comply with the requirements of C.M. 35. The absorption unit shall be of the shell-and-tube type construction. The absorber, evaporator, and condenser shall be suitable for not less than [1,000] [1,700] kPa waterside working pressure. The generator shall have a heating medium of [steam] [hot water] and have a suitable working pressure of [1,000] [1,700] kPa. The absorption unit may be enclosed in one or two shells with removable water boxes or heads. Condenser tubes shall be copper or copper-nickel. Generator tubes shall be copper-nickel. Absorber and evaporator tubes shall be either copper or copper-nickel. Tube ends shall be rolled into or silver brazed to tube sheets. All copper or copper-nickel tubes shall be seamless and be in accordance with C.M. 35. The liquid cooler, within he evaporator, shall be seamless and be in accordance with C.M. 35. The liquid cooler, within the evaporator, shall be designed, constructed, tested, and certified in accordance with UNI 7181, UNI 7182, and UNI 7183. [For double effect absorption chiller[/heaters], first stage concentrator tubes shall be titanium and the steam circuit shall comply with UNI EN 255-3. The header for the double effect unit shall be designed for a steam working pressure of 1,000 kPa and factory tested at 150 percent of design working pressure. Double effect absorption chillers[/heaters] shall be equipped with capacity modulation to control solution flow entering and leaving the first stage concentrator.]

2.2.4.3 Tube Bundles

****

NOTE: The selection of the double-tube bundle is a design function where a steady demand exists for low grade rejected heat. Where this demand does not exist or where the heat recovery cannot be justified, the single-tube bundle should be used.

****

Provide sufficient clearance between tubes and an adequate number of support sheets, with tubes fitted in the sheets, to prevent chafing of tubes or crevice corrosion due to uneven tube expansion, vibration, or pulsation. Holes in tube sheets shall not have sharp corners. Each tube shall be removable, in one piece, through holes individually provided for it in tube and support sheets. Water velocities through cooler, condenser, and absorber tubes shall range from less than 0.91 to 3.66 m/s. Condenser shall be [single] [double]-tube bundle type.

2.2.4.4 Heads

Provide removable, welded-steel or cast-iron heads for external steam and water connections to permit access to tubes for inspection and cleaning. Design and test water spaces for a working pressure of not less than 1034 kPa (gage). Water spaces shall be tested at a pressure of not less than 1.5 times the working pressure.

2.2.4.5 Purge System

Provide chiller with an automatically or manually controlled purge system consisting of a motor driven, jet type, or viscosity type, high vacuum pump with separators, pipe connections, and controls. Provide positive protection against return air to unit when evacuator is not in operation.

2.2.4.6 Crystallization

Provide for automatic decrystallization or anti-crystallization, in accordance with manufacturer's standard. If decrystallization is used, provide and arrange for supplemental heating elements if required for automatic operation.

2.2.4.7 Refrigerant and Absorber

Absorber unit shall be fully charged with water and a nontoxic absorber after installation. Refrigerant and inhibitors shall not generate films that would reduce machine efficiency by coating tubes. The corrosion inhibitor shall not cause the solution to be classified as hazardous waste under D.L. 22.

2.2.4.8 Absorption Unit Pumps

Pumps as required, but not including chilled-water and condenser-water pumps, shall be provided as part of the liquid chilling plant and be

factory mounted. Pumps shall be hermetic type provided with suction and discharge stop valves, when required by the manufacturer, and be complete with piping, fittings, and other required devices. Magnetic across-the-line starter with overhead protection shall be provided in the control panel for each pump.

2.2.4.9 Cleaning Brushes

Furnish chiller with two brushes, having jointed rods, suitable for cleaning evaporator and condenser tubes.

2.2.4.10 Charging and Testing

Unless fully assembled, tested, evacuated, and charged at factory, components shall be dried and sealed to prevent corrosion of internal surfaces prior to field assembly. Assemble, test, evacuate, and charge units under supervision of manufacturer's representative. Periodic tests shall be readily made on the concentration of the inhibitor and lithium bromide solution with a field test kit furnished by manufacturer, or as recommended by manufacturer.

2.3 SPLIT-SYSTEM WATER CHILLERS, REMOTE CONDENSER

****

NOTE: Specify applicable ratio after consulting current literature to ensure an energy-efficient system is provided. The ratios specified shall permit unlimited competition among at least three manufacturers.

****

UNI EN 12055. Base capacity and power ratings, at the conditions indicated and specified, on the test requirements of UNI EN 12055. Power input shall not exceed [_____] kW/kW load at full load capacity. For multicompressor units, not less than two independent refrigerant circuits shall be provided. Chillers shall operate at partial load conditions without increased vibration over normal vibration at full load, and shall be capable of continuous operation down to minimum capacity. Provide insulation for surfaces subject to sweating including the liquid cooler, suction line piping, water boxes, economizer, and cooling lines. Insulation shall conform to Section 15080, "Mechanical Insulation."

2.3.1 Reciprocating Compressors

Provide with forced feed lubrication, crankcase heater, hot-gas muffler, and suction strainer. Cylinder-unloading devices shall be unloaded when compressor starts. Piston speed for open compressor shall not exceed recommendations of manufacturer or 5 m/s, whichever is less.

2.3.2 Helical Rotary Compressors

Positive displacement, oil-injected type, and driven by an electric motor. Rotors shall be solid steel, in accordance with UNI EN 10020. Shaft main bearings shall be either sleeve-design type with leaded bronze or

steel-backed babbit; or frictionless bearing design, ball or roller type. Housings and covers shall be high-grade, cast-iron or aluminum pressure castings. Lubrication system shall lubricate rotors, bearings, shaft seal as well as rotor sealing and cooling. Provide an oil safety cutout interlocked with the compressor starter to allow compressor to operate only when the oil system is operational. Provide for lubrication of bearings and shaft seals on shutdown with or without electrical power supply.

2.3.3 Scroll Compressors

Three-dimensional, compliant, hermetically sealed design. Compressors shall be mounted on vibration isolators. Rotating parts shall be factory balanced. Main bearings shall be rolling-element type. Lubrication systems shall be centrifugal pump type including oil level sight glass and oil charging valve.

2.3.4 Liquid Coolers (Evaporators)

Tubes shall be seamless copper. On direct-expansion-type units, each refrigerant circuit shall be complete with liquid solenoid valve and expansion device capable of modulating to minimum capacity. For the water side of liquid cooler, performance shall be based on a water velocity not less than 0.91 m/s and not more than 3.66 m/s and a fouling factor of 0.00025.

2.3.5 Controls, Control Panels, and Gages

****
NOTE: Specify required time delay for type and size of unit after consulting current literature.
****

****
NOTE: Specify lowest percent of full capacity required. Check for availability before inserting number in blank.
****

Provide a control panel fitted with a discharge pressure gage, suction pressure gage, separate high pressure cutout with manual reset, separate low pressure cutout, low water temperature cutout with manual reset, compressor operating control, and manual off-auto switch. Provide oil pressure gage and low-oil-pressure cutout switch with manual reset for chillers with positive displacement type oil pumps. Provide signal lights or other visual "failed" indications for high pressure, low pressure, and oil pressure protection devices. Multicompressor units shall be provided with a lead/lag selector switch. Provide a timer to prevent compressors from short cycling whenever stopped by safety controls. Time delay shall be not less than [_____] minutes. Pumpdown cycle of the nonrecycling start type shall be provided for each compressor 70 kW or larger. Provide a minimum 100 mm alarm bell and alarm bell circuit to actuate bell in event of machine cutout on protective devices, except when low-pressure cutout is used as an operating control. Provide system capacity control to adjust chiller output to a minimum of [_____] percent of full load capacity

without cycling operating compressor and to automatically recycle system on power interruption. Provide start-up and head pressure controls to allow for system operation at all ambient temperatures down to [_____] degrees C.

2.3.6 Motors and Starters

Provide [across-the-line magnetic] [reduced voltage] type motor starters conforming with CEI EN 60947-4-1. Provide phase failure, over voltage and low voltage protection. Provide induction electric motors conforming with CEI EN 60034-1.

2.3.7 Factory Charging

Dehydrate, purge, and charge refrigerant circuit with refrigerant and oil at factory. Factory oil and refrigerant charge shall be full amount required for operation, if within limits permitted by the Department of Transportation; otherwise, a holding charge shall be furnished. Field charging, where only a holding charge is shipped, shall be accomplished without breaking permanent refrigerant connections.

2.4 COMPRESSOR UNITS

UNI EN 12055. Provide factory-assembled compressor units driven by electric motors. Provide with valves, refrigerant piping, instruments and controls. Provide standard equipment, optional equipment, and accessories specified in UNI EN 12055. Entire unit shall be mounted on a welded steel base. Provide initial charge of refrigerant grade lubricating oil. Compressors shall operate at partial load conditions without increase in vibration over that normally experienced at full load; and shall be capable of continuous operation down to lowest step of unloading as specified.

2.4.1 Reciprocating Compressors

Compressors shall have integrally cast housing of close-grained iron with oil-level bull's eye, cast cylinder heads, cast-aluminum or forged-steel connecting rods, and cast-iron or forged-steel crankshaft. Main bearings shall be sleeve-insert type. Provide forced-feed, positive-displacement type lubrication systems with oil strainer and reversible oil pump. Shaft seals in open-type units shall be mechanical type. Suction and discharge valves shall be flange connected, wrench operated, rising stem, with cap. Rotating parts shall be factory statically and dynamically balanced. Provide crankcase oil heaters and controls. Piston speed for open-type compressors shall not exceed manufacturer's recommendation or 5 m/s, whichever is less. Provide a hot-gas muffler.

2.4.2 Helical Rotary Compressors

Positive displacement, oil-injected and driven by an electric motor. Rotors shall be solid steel, UNI EN 10020. Shaft main bearings shall be either sleeve-design type with leaded bronze or steel-backed babbit; or frictionless bearing design, ball or roller type. Housing and covers shall be high-grade, cast-iron or aluminum pressure castings. Lubrication system shall lubricate rotors, bearings, shaft seal as well as rotor sealing and cooling. Provide an oil safety cutout interlocked with the compressor

starter to allow compressor to operate only when the oil system is operational. Provide for lubrication of bearings and shaft seals on shutdown with or without electrical power supply.

2.4.3 Scroll Compressors

Three-dimensional, compliant, hermetically sealed design. Compressors shall be mounted on vibration isolators. Rotating parts shall be factory balanced. Main bearings shall be rolling-element type. Lubrication systems shall be centrifugal pump type including oil level sight glass and oil charging valve.

2.4.4 Controls

****
NOTE: Specify lowest percent of full capacity required. Check for availability before inserting number in blank.
****

****
NOTE: Specify required time delay for type and size of unit after consulting current literature.
****

Provide a control panel fitted with a discharge pressure gage, suction pressure gage, separate high pressure cutout with manual reset, separate low pressure cutout, compressor operating control, and manual off-auto switch. Provide oil pressure gage and low-oil-pressure cutout switch with manual reset for compressors with positive displacement type oil pumps. Provide signal lights or other visual "failed" indications for high pressure, low pressure, and oil pressure protection devices. Multicompressor units shall be provided with a lead/lag selector switch. Provide a timer to prevent compressors from short cycling whenever stopped by safety controls. Time delay shall be not less than [_____] minutes. A pumpdown cycle of the nonrecycling start type shall be provided for compressors 70 kW or larger. Provide a minimum 100 mm alarm bell and alarm bell circuit to actuate bell in event of machine cutout on protective devices, except when low-pressure cutout is used as an operating control. Provide system capacity control to adjust output to a minimum of [_____] percent of full load capacity without cycling operating compressor and to automatically recycle system on power interruption.

2.4.5 Electric Motors and Starters

Provide polyphase induction motors conforming to CEI EN 60034-1. Provide [across-the-line magnetic] [reduced voltage] motor starters conforming to CEI EN 60947-4-1. Provide phase failure, over voltage and under voltage protection.

2.5 AIR-COOLED CONDENSERS, REMOTE-TYPE

Factory-assembled, design-tested, and rated in conformance with C.M. 35. Condensers shall be ready for operation after installation and field

testing.

2.5.1 Condenser Casings

Aluminum not less than one mm in nominal thickness or steel not lighter than 1.31 mm in nominal thickness. Provide condensers having horizontal air discharge with discharge baffles to direct air upward, constructed of same material and thickness as casing. Provide wire screens or louvers over exposed condenser coil fins not protected by the casing.

2.5.2 Capacity and Cross-Plot

Size condensers for full capacity at 17 degree C temperature difference between entering outside air and condensing refrigerant. Entering dry-bulb, outside design air temperature shall be based on [_____] degrees C. For design conditions, submit a cross-plot of net refrigeration effect of condenser against net refrigeration effect of compressor to establish net refrigeration effect and compatibility of equipment furnished. Subcooling shall not be considered in determining compressor and condenser capacities.

2.5.3 Condenser Coils

****

NOTE: Research project location conditions to determine the environmental effects on finned tube coils. The research should include a survey of existing similar equipment. Prepare project specifications based on the conclusions of the research. Consideration should be given to the following combinations based on past experience of these materials in dealing with the local conditions.

1. Copper tube and aluminum fins, coated

2. Copper tube and copper fins, coated

3. Aluminum tube and aluminum fins, coated

4. Aluminum tube and aluminum fins, uncoated

5. Copper tube and copper fins, uncoated

6. Copper tube and aluminum fins, uncoated.

****

Extended-surface fin-and-tube type. Condenser coils shall be constructed of [copper tube and aluminum fins] [copper tube and copper fins] [aluminum tube and aluminum fins]. Fins shall be hydraulically or mechanically bonded to tubes and installed in a metal casing. Coils shall be circuited and sized for a minimum of 3 degrees C subcooling and full pumpdown capacity. [Provide a coating as specified in the paragraph entitled "Coatings for Finned Tube Coils." Coils to be coated shall be part of the manufacturer's standard product for the capacities and ratings indicated and specified. Fins shall be the plate fin type.]

2.5.4 Fans

For V-belt drive fans, provide adjustable sheave. Fans shall be statically and dynamically balanced. Provide fans with vibration isolation devices to minimize vibration transmission.

2.5.5 Electric Motors and Starters

Provide polyphase induction motors conforming to CEI EN 60034-1. Motor bearings shall be permanently lubricated. Provide across-the-line magnetic motor starters conforming with CEI EN 60947-4-1. Provide phase failure over voltage and low voltage protection.

2.5.6 Condenser Controls

****
NOTE: Insert winter design temperature that the equipment will be subjected to.
****

Provide start-up and head pressure controls to allow for system operation at all ambient temperatures down to [_____] degrees C.

2.6 WATER-COOLED CONDENSERS, REMOTE-TYPE

Provide shell-and-coil or shell-and-tube type constructed, tested, and rated in accordance with UNI 8724. Refrigerant side design pressure shall comply with C.M. 35. Water side design pressure shall be not less than 1034 kPa (gage).

2.6.1 Shell-and-Coil Condensers

Fabricate with seamless or welded steel shell and welded head. Water shall flow through the coil which shall be nonferrous metal, plain or integral finned, and arranged to drain completely. Coil joints shall be brazed or silver soldered. Entire bundle shall be removable.

2.6.2 Shell-and-Tube Condensers

Fabricate with seamless or welded steel shell, steel tube sheets, and cast-iron or steel water boxes. Tubes shall be nonferrous metal, plain or integral finned, and shall be expanded full diameter into reamed and grooved holes, silver soldered or brazed. Provide intermediate tube supports for lengths of straight tubing between supports every 0.91 meter for copper tubes, and every 1.22 meters for brass tubes. Tubes shall fit in the support to prevent chafing due to vibration or pulsations.

2.6.3 Accessories

Provide condensers with the following accessories:

a. Purge connections;

b. Relief devices;

c. Refrigerant valves;

d. Liquid-level indicating devices;

e. Companion flanges, bolts, and gaskets for flanged water connections;

f. Stands or saddles; and

g. Water drain connections.

2.6.4 Performance

Base performance on water velocities not less than 0.91 m/s nor more than 3.66 m/s and fouling factor of 0.0005. Water-cooled condensers may be provided for refrigerant storage in lieu of a separate liquid receiver, provided that condenser storage capacity is 20 percent in excess of fully charged system.

2.6.5 Condenser Controls

[When refrigerant discharge pressure decreases, a pressure controller shall modulate a three-way valve to mix leaving condenser water.] [When water temperature leaving condenser decreases, cooling tower fan shall be de-energized.] Controls shall be set for a saturated refrigerant condensing temperature of 40 degrees C.

2.7 LIQUID COOLERS, REMOTE-TYPE

Direct expansion flooded type; constructed, tested, and rated in conformance with C.M. 35. Refrigerant side design pressure shall comply with C.M. 35. Water side design pressure shall be not less than 1034 kPa (gage). Tubes shall be seamless copper. On direct expansion units, each refrigerant circuit shall be complete with liquid solenoid valve and expansion device capable of modulating to minimum step of capacity unloading. For water side of liquid cooler, performance shall be based on a water velocity ranging from 0.91 to 3.66 m/s with a fouling factor of 0.00025.

2.8 COOLING TOWERS

****

NOTE:
Research the project location atmospheric and water conditions to determine there effects on cooling tower materials. The research should include a survey of existing towers. Base material selection on life cycle cost analysis. Factory-assembled wood cooling towers may be a restrictive product (i.e., three manufacturers may not exist). Level 1, Contracting Officer, approval is required if it is established conclusively that no option other than a

factory-assembled wood cooling tower will serve the purpose, and less than three manufacturers exist.

Fire Safety: Design cooling towers having wood fill with heat responsive devices and remote controls to flood entire normal water distribution system in case of fire in dry cells of cooling towers. Indicate heat responsive devices under fan decks, distribution basins, or in other locations where necessary for activation. Where heat responsive devices are inaccessible, provide controls to test the system. Operation of heat responsive devices shall activate building fire alarm system, stop cooling tower fans, and provide both audible and visual signals on the air conditioning central control panel. Remote controls to flood normal water distribution system shall be quick action type. The design shall conform to the requirements of UNI 8774 FA 1-89 "Water-Cooling Towers."

****

2.8.1 Fire Safety

Towers shall conform to UNI 8774/FA-1. Fire hazard rating for plastic impregnated materials shall not exceed 25. Plastics shall not drip or run during combustion.

2.8.2 Enclosures

Enclosures shall meet tower manufacturer's recommendations.

2.8.3 Supporting Members

Where supporting members are indicated, verify their size and locations to ensure the adequacy of the support systems. Provide modifications to tower supports, steel members, and vibration isolation units for particular tower to be furnished.

2.8.4 Factory-Assembled Towers

Cooling towers shall be factory-assembled type, conforming to UNI 8774/FA-1 with the following requirements:

a. Induced Mechanical Draft.

b. Constructed of [zinc-coated steel] [stainless steel] [wood] [fiberglass-reinforced plastic]. No asbestos-cement materials will be permitted.

c. Hardware shall be [cadmium plated] [zinc-coated] [stainless steel] except nails shall be [silicon bronze] [commercial bronze] [stainless steel].

d. Vibration cutout switch shall be provided and interlocked with the

fan motor.

e. Fill or contact surfaces shall be [polyvinyl chloride (PVC) formed sheets] [zinc-coated steel] [wood]. No plasticized cellulose materials will be permitted.

f. Field performance test is not required.

[g. Fifteen-percent increase in design structural loading shall be included for ice or snow load.]

[h. Air inlet and discharge terminations shall have flanged or lipped projections for connecting ductwork.]

[i. Fan motor shall be 2-speed.]

2.8.5 Field-Assembled Cooling Towers

Induced-draft, counterflow or crossflow type, and either spray-filled or wetted-surface type. Field-assembled towers shall include those where a majority of assembly work is done at the project location.

2.8.5.1 Sound Power Levels

****
NOTE: Choose one of the following options.
****

****
NOTE: Specify sound power levels after considering location and application of cooling tower. Delete first paragraph if project includes Section 15070, "Mechanical Sound, Vibration, and Seismic Control." Delete second paragraph if project does not include Section 15070, "Mechanical Sound, Vibration, and Seismic Control."
****

[Sound power levels (in decibels with a reference pressure of 0.0002 microbar) of the cooling tower shall not exceed the maximum permitted decibel levels for the designated octave band as set forth in the following tables. Base the sound power level data for the cooling tower on tests conducted in accordance with UNI EN ISO 3744.

Octave Band (in Hz)	63	125	250	500	1000	2000	4000	8000
Sound Power Level in dB	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]]

[Sound level criteria shall conform to Section 15070, "Mechanical Sound, Vibration, and Seismic Control."]

2.8.5.2 Design

Notching structural members is permissible only if the members are increased proportionately in size to provide equivalent strength. Towers shall be designed and constructed to withstand a wind pressure of not less than 1437 Pa on external surfaces. Fan decks shall be designed to withstand a live load of not less than 2874 Pa in addition to the concentrated or distributed loads of equipment mounted on the fan decks. [A 15-percent increased loading shall be included for ice or snow load.]

2.8.5.3 Identification Markings

Identification shall be permanently and legibly marked directly on the tower or on a corrosion-resisting metal plate securely attached to the tower at the source of manufacture. Identification shall include the manufacturer's model and serial number, name, and trademark and be readily identifiable to the manufacturer.

2.8.5.4 Woods

Redwood and red cypress shall be clear of all heart grade, except for structural framing members and inner casings of double-cased towers, which may be select heart grade. Douglas fir and hemlock grades shall be similar to redwood and red cypress grades. Plywood shall be marine type, pressure treated, with B-grade face and back and C-grade inner plies. Protect cut edges.

2.8.5.5 Wood Treatment

Douglas fir and west coast hemlock used in the construction cooling towers shall have a preservative treatment. Wood exposed as the result of notching, cutting, or drilling shall be saturated with the preservative.

2.8.5.6 Fiberglass-Reinforced Plastics

Provide corrosion-proof, fire-retardant plastics in tower construction. Plastics shall be manufacturer's standard commercial material and shall meet conditions specified herein. Components manufactured of polystyrene will not be permitted.

2.8.5.7 Hardware

Cadmium-plated, stainless steel, or zinc-coated steel. Angle brackets and similar parts shall be cast iron or zinc-coated steel. Zinc coatings shall conform to UNI EN 10240, as applicable, and shall have an extra heavy coating of not less than 0.76 kg per square meter of surface. Nails shall be silicon bronze, commercial bronze, or stainless steel. Subject hardware to a salt-spray fog test in accordance with UNI ISO 9227. No signs of corrosion shall be evident after 1,000 hours continuous exposure to a 5 percent salt spray.

2.8.5.8 Basins

[Wood] [Concrete] construction and have capacity so that air will not be

entrained in outlets when operating, and no water will overflow on shutdown. Basin may be rectangular, flat-bottom type, V-bottom type, or shallow-pan type with deep storage sump. Provide each flat-bottom basin with one or more steel, cast-iron, or concrete outlet sumps of such size and depth as to prevent cavitation and air entrainment under operating conditions. If a single outlet is indicated, and the Contractor elects to provide two or more sumps, additional header piping of same size as outlet pipe shown shall be provided. Provide outlets with removable screens. Screens shall consist of 13 mm mesh, zinc-coated steel wire fastened to 32 by 32 by 4.76 mm angle frames of zinc-coated steel. Total screen area below operating water line shall be not less than 0.0929 square meter for each 25.24 L/s of specified tower capacity. Individual sections of screens shall not weigh over 45.40 kg. Provide each basin with an overflow to carry off excess flow due to incorrect adjustment of float, and a valved drain connection. Pipe overflow and drain connections to nearest sewer drain. Provide basins with a float-controlled, makeup water valve, located so as to discharge not less than 50 mm or two pipe diameters, whichever is greater, above top of basin. Hose bibb of 20 mm nominal size shall be provided near tower casing. Connect makeup valve and hose bibb as indicated.

2.8.5.9 Wood Basins

Fabricate wood basins of 40 mm tongue and groove wood, caulked with cotton wicking and mastic, or 20 mm or heavier plywood with plywood battens. Sides shall be through bolted to bottom whenever feasible and to battens at joints and corners. Sides may be same material as bottoms or of two layers of 10 mm plywood.

2.8.5.10 Concrete Basins

Concrete shall be 20 MPa class in accordance with Section 03300, "Cast-In-Place Concrete," reinforced as indicated.

2.8.5.11 Casings

Fabricate from double-sheathed wood, or fiberglass-reinforced plastic. Wood sheathing shall be not less than 15 mm tongue and groove. Partitions between cells shall be single-sheathed wood and shall extend from fan deck to bottom of fill except for down flow towers, which shall extend to top of fill.

2.8.5.12 Fan Decks

Fabricate from plywood a minimum of 29 mm thick. Fan decks shall be designed to support a 293 kg/m2 live load.

2.8.5.13 Stairways and Ladders

Provide stairs, 1.047 rad ship ladders or straight-rung ladders of standard design, starting at [ground] [roof] level and extending as high as required to gain access to fan decks and water distribution systems. Stairways and ladders, shall be hot-dip, zinc-coated steel. Ladders higher than 3.5 meters shall have a safety cage.

2.8.5.14 Handrailings

Steel handrailings shall be not less than 1067 mm high around the exterior of each working surface that is 3.5 meters or more above the ground, roof, or other supporting construction. Railings shall be not smaller than 32 mm zinc-coated steel pipe with standard zinc-coated steel railing.

2.8.5.15 Access Doors

Provide casings and fan decks with access doors to reach interior tower parts without removal of fill. Provide access doors in each endwall of each cooling tower cell. Frame and brace access doors to prevent damage when opening and closing. Locate doors adjacent to float controls.

2.8.5.16 Louvers

Provide air inlet openings in casings with individually removable louvers arranged to prevent escape of water. Fabricate from wood or fiberglass-reinforced plastic. When different materials are provided for casings and louvers, they shall be compatible; and one material shall not produce stains upon the other.

2.8.5.17 Fill

****

NOTE: Fire Safety: Design cooling towers having wood fill with heat responsive devices and remote controls to flood entire normal water distribution system in case of fire in dry cells of cooling towers. Indicate heat responsive devices under fan decks, distribution basins, or in other locations where necessary for activation. Where heat responsive devices are inaccessible, provide controls to test the system. Operation of heat responsive devices shall activate building fire alarm system, stop cooling tower fans, and provide both audible and visual signals on the air conditioning central control panel. Remote controls to flood normal water distribution system shall be quick action type. The design shall conform to the requirements of UNI 8774 FA 1-89 "Water-Cooling Towers."

****

Polyvinyl chloride (PVC) formed sheets or designed as individual fill batts, or zinc-coated steel [, or treated Douglas-fir; treated hemlock; or treated redwood]. Zinc-coated steel shall have a minimum of 0.76 kg of zinc per square meter of surface. PVC fill shall not be provided when inlet temperatures exceed 52 degrees C. No plasticized wood cellulose shall be provided for fill material. Fill shall be removable or otherwise made accessible for cleaning. Fill supports shall be wood or glass-reinforced polyester. Supports shall have structural strength of not less than five times design loading. Provide space supports as required to

prevent sagging and misalignment, and provide for an even mixing of air and water.

2.8.5.18 Water Distribution Systems

Design water distribution systems for each cell of each tower so that a water flow of 140 percent of specified water flow will not cause overflowing or splashing. Water distribution systems shall be accessible and permit flexibility of operation. Distribution shall be open basin, flume and troughs, or a pipe system with nozzles spaced for even distribution, arranged so that flow to each cell can be regulated and turned on or off independently. Provide separate regulation and stop valves for complete balancing and complete shutoff from each cell. Systems shall be self-draining and nonclogging. Spray nozzles, if used, shall be cleanable; stainless steel, bronze, or high-impact plastic, nonclogging, removable; and, spaced for even distribution. Provide removable covers of same material and thickness as casing for entire water distribution basin. Support covers by basin sides with top of cover flush with top of basin.

2.8.5.19 Piping

Provide inlet pipe to each cell with a bleed connection. Connections shall have a regrinding globe valve set to pass 1.05 mL/s for each 760 mL/s of rated cell capacity. Piping shall be installed under direct supervision of the tower manufacturer.

2.8.5.20 Drift Eliminators

Provide in tower outlet to limit drift loss to not over 0.2 percent of specified water flow. Eliminators shall be constructed of not less than 10 mm wood or polyvinyl chloride (PVC).

2.8.5.21 Fans

Provide each tower cell with one or more fans driven by electric motors, dynamically balanced. Provide propeller fans with adjustable-pitch air foil blades with a maximum tip speed of 56 m/s. Fan blades shall be aluminum, stainless steel, or fiberglass.

2.8.5.22 Fan Stacks

Provide propeller fans with stacks of wood or fiberglass-reinforced plastic. Minimum thicknesses of material shall be: Wood, 15 mm laminations reinforced at top and bottom; fiberglass-reinforced plastic, 4 mm. Stacks shall be provided with a zinc-coated steel screen of 2.69 mm wire and not over 13 mm mesh secured to a frame of zinc-coated steel.

2.8.5.23 Fan Drives

Mount fan on output shaft of a gear box with cut steel spiral, hypoid, or other equally quiet and efficient gears. Bearings shall be ball or roller type with a continuous oiling system with oil reservoir. Oil-level indicators and oil filling and drain connections shall be provided outside fan cylinder in an accessible location. If drain connection is below level

of fan deck, drain pipe shall be extended to outside of tower at an accessible location. Rate gearing in accordance with fan gearing manufacturer's instructions with a service factor of 2 for cooling tower service. Gear reducers shall be spiral-bevel type for single reduction and spiral-bevel and helical with parallel shaft for double reduction. Drive shafts shall be of stainless steel and full-floating type, fitted at each end with stainless-steel-plate type flexible couplings.

2.8.5.24 Fan Motors

[Single speed] [Two speed], totally enclosed, insulation service factor, continuous-rated, and conforming to CEI EN 60034-1. [Two-speed motors shall have a single winding with variable torque characteristics.]

2.8.5.25 Motor Starters

Reduced voltage with low voltage protection and thermal-overload manual reset relays. Starters shall conform to applicable CEI 64-8. [Two-speed motor starters shall be provided with a speed selecting switch as part of the starter.]

2.8.5.26 Vibration Cutout Switches

Provide for each fan and interlock with motor wiring to stop motor under excessive fan vibration.

2.8.6 Tile Filled Towers

****

NOTE: Where tile filled towers are to be used in base bid or as an alternate, drawings must be coordinated to assure that structural loading has been incorporated in the design and that all construction details have been reflected on drawings. Indicate whether fan deck is to be furnished by tower manufacturer or under general construction.

****

Provide counterflow, induced-draft type with capacity as indicated.

2.8.6.1 Basins

Construct concrete basins using a continuous pour containing a waterproof additive in conformance with Section 03300, "Cast-In-Place Concrete." Provide each basin with one or more steel, cast-iron, or concrete outlet sumps sized to prevent cavitation and air entrainment under operating conditions. If a single outlet is indicated, and the Contractor elects to furnish two or more sumps, additional header piping of same size as outlet pipe shown shall be provided. Provide each outlet with a removable screen. Screens shall consist of 15 mm mesh, zinc-coated steel wire fastened to 32 by 32 by 4.76 mm zinc-coated steel angle frames conforming to UNI EN 10240. Total screen area below operating water line shall be not less than 0.0929 square meter for each 25.24 L/s of specified tower capacity. Individual

section of screens shall not weigh over 45.40 kg. Provide each basin with an overflow and a valved drain connection. Pipe overflow and drain connections to nearest sewer drain. Provide each basin with a float-controlled makeup water valve, located to discharge not less than 50 mm or two pipe diameters, whichever is greater, above top of basin. Install a hose bibb of 20 mm nominal size near tower casing. Connect makeup and hose bibb to water supply as indicated.

2.8.6.2 Walls

Construct with mortar having a waterproof additive in conformance with Section 03300, "Cast-In-Place Concrete." Cover built-up masonry interior walls of each cell completely with a membrane of fiberglass sheets of commercial, first-quality, polyester-resin reinforced with fiberglass mat, and secure to walls from top to bottom. Secure fiberglass sheets to walls with cadmium-plated nails spaced not less than 610 mm on center in any direction. Seal nail heads and joints with polyester-resin-reinforced fiberglass stripping rolled into place. Apply finish coat of polyester resin, not less than 2 mm, over entire membrane after completion of hanging and stripping.

2.8.6.3 Fan Decks and Stacks

Construct fan decks of precast, reinforced lightweight concrete, in multiple sections, forming a complete, vibration-free base for mounting fan, speed reducer, drive shaft, motor, and fan stacks. Construct fan stacks of precast, reinforced lightweight concrete in multiple sections, constrained with bands of zinc-coated steel conforming to UNI EN 10240, not less than 3 by 76 mm, and bolted to form a compressive load on stack perimeter. Secure stack in place on fan deck with Class A mortar.

2.8.6.4 Fill

Tile fill shall be multicellular design, set without mortar in a pattern of sufficient height to meet indicated performance. Tile shall be dense and vitreous, with a water absorption not to exceed 2 percent in a one-hour boil test. Tile shall have minimum crushing strength of 2758 kPa over gross area of tile, when load is applied parallel to cells. Support tile fill by cast-iron tee section lintels of gray iron castings designed with a safety factor of three, plus 3 mm additional thickness for corrosion.

2.8.6.5 Water Distribution Systems

Provide each tower cell with a water distribution system and separate regulation and stop valves for complete balancing and shut-off of each cell. Distribution system for each cell shall consist of a centrally located header complete with junction boxes and side laterals, fittings, and nozzles. Piping 80 mm and larger on the tower side of the shut-off valve, junction boxes, and fittings shall be cast iron. Nozzles shall be brass conforming to UNI 6346. Piping smaller than 80 mm shall be [standard weight galvanized-steel pipe with threads epoxy coated] [fiberglass-reinforced plastic pipe]. Cast-iron pipe shall be centrifugally cast and shall conform to UNI 5339. Cast-iron flanged and screwed fittings shall conform to UNI EN 1092-2, respectively.

2.8.6.6 Inlet Pipe

Provide to each cell with a bleed connection having a regrinding type globe valve set to bypass 1.05 mL/s for each 760 mL/s of rated cell capacity.

2.8.6.7 Drift Eliminators

Fabricate from fiberglass-reinforced polyester resin, mold-formed and power pressed in multipass zigzag form. Support eliminator sections on fiberglass tee sections supported by stainless steel clips embedded in fan deck by 6.35 mm brass rods. Free water carryover shall not exceed 0.05 percent of tower capacity.

2.8.6.8 Fans

Design fan assembly (fan and mounting) to give maximum fan efficiency and long life when handling saturated air at high velocities. Provide fans balanced by fan manufacturer either by individual blades or matched sets and of multiblade design with a minimum of six aluminum, stainless steel, or fiberglass blades. Fan hub shall be made of aluminum, ductile iron, stainless steel, or fabricated steel (hot-dip galvanized after fabrication), with adequate surface protection against corrosion. Tip speed of blades shall not exceed 56 m/s to ensure maximum quietness of operation. Where required by manufacturer or where needed for critical applications to avoid structural transmission of machine noise, provide hot-dipped, galvanized plates bolted and grouted to concrete deck after alignment of fan motor and gear box, with galvanized or stainless steel hold down bolts; or provide a unitized motor and gear support base of structural steel with vibration isolation units. Speed reducer gears shall be rated in accordance with AGMA using service factor of 2 for cooling tower services. Gear reducers shall be spiral-bevel type for single reduction and spiral-bevel and helical with parallel shaft for double reduction. Drive shafts shall be stainless steel and shall be full-floating type, fitted at each end with stainless-steel-plate type flexible couplings.

2.10 ACCESSORIES

2.10.1 Refrigerant Leak Detector

****

NOTE: Refrigerant leak detectors will be provided as required by the "System Application Requirements" in ASHRAE 15.

When a detector is required, the location will be indicated on the drawings. Detectors are best located between the refrigeration system and the room exhaust. Sampling points from a detector will be located a maximum of 460 mm above the finished floor since all commonly-used refrigerants are heavier than air.

As a rule of thumb, the distance between any refrigeration system and a refrigerant sampling point should not exceed 15 meters. In order to meet the recommended 15 meter distance, a mechanical room can be provided with either multiple detectors each with single sampling points or with one detector that has the capability of monitoring at multiple sampling points. If multiple sampling points are required, enter the number in the appropriate blank below.

Per ASHRAE 15, when a detector senses refrigerant it must activate an alarm and initiate the room ventilation system. In regards to alarms, as a minimum, indicate that the detector will energize a light on or near the detector as well as a second light installed on the outside wall next to the mechanical room entrance. The exterior light will be provided with a sign that warns personnel entering the mechanical room of a refrigerant release and that a SCBA is required to enter. If applicable to the installation, include an audible alarm on the exterior of the mechanical room. Include the electrical design for the alarm system on the drawings.

As an additional item, ASHRAE 15 states that open-flame devices (i.e., boilers, etc.) cannot be installed in the same area as a refrigeration system, unless either combustion air for the open-flame device is ducted straight from outside to the device; or the alarm relay from the detector is used to automatically shutdown the combustion process in the event of refrigerant leakage. Indicate all applicable alarm controls on the drawings.

Delete the information in the last bracketed sentences if an EMCS is not applicable to the design.

****

Detector shall be the continuously-operating, halogen-specific type. Detector shall be appropriate for the refrigerant in use. Detector shall be specifically designed for area monitoring and shall include [a single sampling point] [_____ sampling points] installed where indicated. Detector design and construction shall be compatible with the temperature, humidity, barometric pressure and voltage fluctuations of the operating area. Detector shall have an adjustable sensitivity such that it can detect refrigerant at or above 3 parts per million (ppm). Detector shall be supplied factory-calibrated for the appropriate refrigerant(s). Detector shall be provided with an alarm relay output which energizes when the detector detects a refrigerant level at or above the TLV-TWA (or toxicity measurement consistent therewith) for the refrigerant(s) in use. The detector's relay shall be capable of initiating corresponding alarms

and ventilation systems as indicated on the drawings. Detector shall be provided with a failure relay output that energizes when the monitor detects a fault in its operation. [Detector shall be capable with the facility's energy management and control system (EMSS). The EMCS shall be capable of generating an electronic log of the refrigerant level in the operating area, monitoring for detector malfunctions, and monitoring for any refrigerant alarm conditions.]

2.10.1.1 Breathing Apparatus

Provide 2 emergency breathing apparatus assemblies; each consisting of an oxygen tank, regulator, respirator, and breathing hoses with a backpack harness. Provide wall mounted hanging device for each unit.

2.10.2 Refrigerant Relief Valve/Rupture Disc Assembly

****

NOTE: ASHRAE 15 requires refrigeration systems to be protected with a pressure-relief device that will safely relieve pressure due to fire or other abnormal conditions. A relief valve/rupture disc assembly is the optimum solution. The rupture disc will provide visual indication of a release while also providing immediate shutoff once a safe pressure is achieved.

Designer will indicate on the drawings the location of each new relief valve/rupture disc assembly as well as the routing and size of corresponding pressure-relief piping. The routing and size of new pressure-relief piping will be per ASHRAE 15.

****

The assembly shall be a combination pressure relief valve and rupture disc designed for refrigerant usage. The assembly shall be in accordance with ASME BPV IX and ASHRAE 15. The assembly shall be provided with a pressure gauge assembly which will provide local indication if a rupture disc is broken. Rupture disc shall be the non-fragmenting type.

2.10.3 Refrigerant Signs

Refrigerant signs shall be a medium-weight aluminum type with a baked enamel finish. Signs shall be suitable for indoor or outdoor service. Signs shall have a white background with red letters not less than 12 mm in height.

2.10.3.1 Installation Identification

Each new refrigerating system shall be provided with a refrigerant sign which indicates the following as a minimum:

a. Contractor's name.

b. Refrigerant number and amount of refrigerant.

c. The lubricant identity and amount.

d. Field test pressure applied.

2.10.3.2 Controls and Piping Identification

Refrigerant systems containing more than 50 kg of refrigerant shall be provided with refrigerant signs which designate the following as a minimum:

a. Valves or switches for controlling the refrigerant flow [, the ventilation system,] and the refrigerant compressor(s).

b. Pressure limiting device(s).

2.10.4 Refrigerant Recovery/Recycle System

****

NOTE: A refrigerant recovery/recycle system will not be specified if the designer determines that on site staff will not be responsible for chiller teardown or major service. If the designer determines the on site staff will be responsible for chiller teardown or major service, the designer shall investigate whether another recovery/recycle system is available to maintenance personnel before specifying a new system. The recovery/recycle system is an expensive item and all alternatives to providing a new system should be investigated.

If a refrigerant recovery/recycle system is specified, the recovery/recycle system shall be tested and listed to conform to the requirements of ARI 740 for refrigerant recovery/recycle systems by a recognized national testing laboratory. The system shall include separate storage vessel(s) capable of storing the entire refrigerant charge of the largest chiller.

The recovery/recycle unit shall be portable. Chiller mounting or floor mounting of the system is expensive and therefore is discouraged.

****

A manually initiated refrigerant recovery/recycle system shall be provided, consisting of a motor-driven, air- or water-cooled, reciprocating condensing unit and a receiver of sufficient capacity to store the entire refrigerant charge of the largest water-chilling system. For refrigerants with atmospheric pressure boiling temperature below 20 degrees C, the receiver shall be sized so that it is no more than 80 percent full at 32 degrees C. For refrigerants with atmospheric pressure boiling temperature above 20 degrees C, the receiver shall be sized so that it is no more than 90 percent full at 32 degrees C. The recovery/recycle system condensing unit shall be assembled as a complete unit and meet the requirements of

ASHRAE 15. The system components shall be portable and shall include all valves, connections, and controls required for operation. Receiver and relief devices shall conform to the requirements of ASME BPV VIII Div 1. The recovery/recycle system shall be tested and listed to conform to ARI 740 for refrigerant recovery/recycle systems by a recognized national testing laboratory. For refrigerants with atmospheric pressure boiling temperature below 20 degrees C, the recovery/recycle unit shall have an ARI 740 vapor refrigerant recovery rate of no less than 8.5 kg/minute. For refrigerants with atmospheric pressure boiling temperature above 20 degrees C, the recovery/recycle unit shall have an ARI 740 vapor refrigerant recovery rate of not less than 1.0 kg/minute.

2.10.5 Mechanical Room Ventilation

****

For mechanical rooms which are intended to house refrigeration equipment, designers will use ASHRAE 15 to determine applicable design criteria. Delete this paragraph if a mechanical room is not applicable to the design.

In summary, ASHRAE 15 allows the use of either natural or mechanical ventilation systems, however natural ventilation is allowed only in certain limited applications. Natural ventilation is allowed only when "a refrigerant system is located outdoors more than 6 meters from building openings and is enclosed by a penthouse, lean-to or other open structure", otherwise mechanical ventilation is required.

The amount of ventilation air required for a mechanical room will be determined based upon the ventilation equations in ASHRAE 15. In order to use these equations, a designer must approximate the mass of refrigerant kgs expected in the largest system located in the mechanical room. Refrigerant quantities will be determined based upon a minimum of 2 different system manufacturers.

a. For a natural ventilation system, ASHRAE 15 provides an equation for sizing the amount of free opening area required.

b. For a mechanical ventilation system, ASHRAE 15 requires both normal and alarm ventilation. Normal ventilation will be sized to cover personnel ventilation requirements 2.5 1/s/m2 and heat buildup requirements if applicable. Alarm ventilation will be sized based upon the equations in ASHRAE 15. Both the normal and alarm ventilation rates can be achieved using the same ventilation system (e.g., multi-speed exhaust fans), however, individual systems are preferred. For the alarm ventilation,

exhaust intakes will be located near the equipment and close to the finished floor. Most commonly used refrigerants are heavier-than-air and subsequently sink to the floor. Also per ASHRAE 15, air supply and exhaust ducts to the mechanical room will serve no other area within a facility. Discharge air from a mechanical ventilation system will be to the outdoors.

****

Mechanical ventilation systems shall be in accordance with Section 15720, "Air Handling Units" and Section 15810, "Ductwork and Ductwork Accessories".

2.9 COOLING TOWER WATER TREATMENT SYSTEMS

****

NOTE: If the activity has a cooling water treatment contract in effect, ensure that the system specified is compatible with it.

****

Capable of automatically feeding chemicals, and bleeding system water to prevent scale, corrosion, and biological growths. Systems shall include chemical feed pump, tank, bleed-off solenoid valve, electric impulse water meter, electric timer, and conductivity controller. Provide a polyethylene tank and injection valve assembly for each feed pump.

2.9.1 Feed Pumps

Positive displacement type with an adjustable capacity and discharge pressure not less than 1.5 times the line pressure at the point of connection. Provide with pressure relief valve, and check valve mounted in the pump discharge.

2.9.2 Tanks

Construct of high density polyethylene, cylindrical in shape, and with a hinged cover. Tanks shall have sufficient capacity to require recharging only once per 7 days during normal operation. Provide tanks with a valved cold water line and, if necessary, a valved hot water fill line with suitable air gap. Provide tanks with device to indicate quantity of solution in the tank. Provide electric mixing device with tank.

2.9.3 Valve Injection Assemblies

Provide for each feed pump. Construct of bronze or material suitable for chemicals being used and install in condenser water line common to all pumps. Injection fittings shall have male pipe threads. Assemblies shall include shut-off valve and check valve provided close to condenser water line.

2.9.4 Bleed-Off Solenoid Valves

Provide in bleed-off line. Valves shall normally be in closed position and

be opened by a 120-volt waterproof solenoid coil. Connect bleed-off line to condenser water line and include a gate valve ahead of solenoid valve. Extend a discharge line from solenoid valves to sewer drain.

2.9.5 Water Meters

Provide with electric contacting register, and remote accumulative counter and installed in make-up water line near cooling tower. Meters shall be standard product used in water treatment.

2.9.6 Timers

Automatic reset, adjustable type, and electrically operated. House in metal CEI type cabinet with a hinged front. Timers shall be suitable for 120 volt current.

2.9.7 Conductivity Controllers

Controllers shall measure total dissolved solids in system water by conductivity. Conductivity sensors shall consist of epoxy insulated carbon electrodes and shall not require platinizing. Controllers shall have a meter with a visual readout, set point adjustment with a range between 200 micromhos/cm and 4000 micromhos/cm and a red pilot light indicating water conductivity above set point. Units shall operate from a 120-volt power source.

2.9.8 Control Panels

Provide a factory-wired, CEI 64-8, control panel for each system. Construct of steel with hinged door and lock, and suitable for surface mounting. Pre-wire controls to numbered terminal strips. Provide laminated plastic nameplates identifying the switch function. Include the following with the panel:

a. Main power switch and indicating lamp;

b. MAN-OFF-AUTO selector switch;

c. Indicating lamp for bleed-off valve;

d. 220 Volt, heavy-duty, grounded duplex receptacle;

e. Conductivity controller;

f. Electric timer; and

g. Accumulative counter.

2.9.9 Sequence of Operation

2.9.9.1 Conductivity Controllers

Provide to open the bleed-off solenoid valve when conductivity of cooling water rises above set point of controller. When conductivity falls below

set point, valve shall close.

2.9.9.2 Water Meters

Provide to start timer after a pre-set volume of make water has been measured.

2.9.9.3 Timers

Provide to turn feed pumps on for a pre-set amount of time.

2.9.10 Piping

Provide plastic piping and fittings conforming to UNI EN 761 for water treatment system. Piping for feed pump suction shall contain a foot valve and strainer.

2.9.11 Water Analysis

****

NOTE: If a water analysis is not available for inclusion in the project specifications, choose the second bracketed option and leave the description table blank.

****

[Make-up water conditions are as follows:] [Provide make-up water analysis in accordance with the methods of tests of D.P.R. 236. Analysis shall include test results for the following:]

Description	
Silica (Si02)	[_____]
Insoluble	[_____]
Iron and Aluminum Oxides	[_____]
Calcium (Ca)	[_____]
Magnesium (Mg)	[_____]
Sodium and Potassium (Na and K)	[_____]
Carbonate (C03)	[_____]
Bicarbonate (HC03)	[_____]
Sulfate (S04)	[_____]
Chloride (C1)	[_____]
Nitrate (N03)	[_____]
Turbidity	[_____]
pH	[_____]
Residual Chlorine	[_____]
Total Alkalinity	[_____]
Noncarbonate Hardness	[_____]
Total Hardness	[_____]
Dissolve Solids	[_____]
Fluorine	[_____]
Conductivity	[_____]

2.9.12 Chemicals

****
NOTE: Choose one of the following options.
****

[Provide same chemicals used for treatment at station's other towers.]

[Provide chemicals in accordance with requirements of United States Environment Protection Agency, and the equipment manufacturer's recommendations. Chemicals shall have no detrimental effects on the materials in the systems. No chromium, zinc, or other heavy metal will be permitted. Chemicals shall be designated by chemical composition and also described by brand name.]

2.12 ELECTRICAL

****
NOTE: Coordinate the requirements specified in this paragraph with the requirements specified in the sections referenced.
****

2.12.1 Electrical Motors, Controllers, Contactors, and Disconnects

Furnish with respective pieces of equipment. Motors, controllers, contactors, and disconnects shall conform to Section 16402, "Interior Distribution System", except as supplemented and modified by this section. Provide electrical connections under Section 16402, "Interior Distribution System." Provide controllers and contactors with maximum of [220] [110] [24] [___] volt control circuits, and auxiliary contacts for use with controls furnished. When motors and equipment furnished are larger than sizes indicated, the cost of providing additional electrical service and related work shall be included under this section.

2.12.2 Electrical Work

Provide under Section 16402, "Interior Distribution System." [Provide control wiring under Section 15901, "Space Temperature Control Systems."] [Provide control wiring under Section 15910, "Direct Digital Control Systems."] [Provide control wiring under this section in accordance with CEI 64-8.]

2.10 COATINGS FOR FINNED TUBE COILS

****
NOTE: Research project location conditions to determine the environmental effects on finned tube coils. The research should include a survey of existing similar equipment. Prepare project specifications based on the conclusions of the research. Consideration should be given to the following combinations based on past experience of these materials in dealing with the local conditions.

1. Copper tube and aluminum fins, coated

2. Copper tube and copper fins, coated

3. Aluminum tube and aluminum fins, coated

4. Aluminum tube and aluminum fins, uncoated

5. Copper tube and copper fins, uncoated

6. Copper tube and aluminum fins, uncoated.

Include this article when coating of finned tube coils is required by the equipment specification paragraphs.

****

Where expressly stipulated in equipment specification paragraphs in this section, finned tube coils of the affected equipment items shall be coated as specified below.

2.10.1 Phenolic Coating

Coating shall be applied at the premises of a company specializing in such work. Coils shall be degreased and prepared for coating in accordance with coating applicator's standard procedures for the type metals involved. Coating material shall be a resin base thermosetting type phenolic. Phenolic coating shall be applied by immersion dipping of the entire coil. Minimum of two coats shall be applied by immersion dipping. Coils shall be baked or heat dried following each immersion. After final immersion and prior to final baking, entire coil shall be given a spray coating of phenolic with particular emphasis given to building up coating on sheared edges. Completed coating shall show no evidence of softening, blistering, cracking, crazing, flaking, or loss of adhesion. There shall be no evidence of phenolic "bridging" between the fins. Minimum dry film thickness of coating shall be 0.038 mm.

20.1.2 Vinyl Coating

****

NOTE: Include the paragraphs below only in PACNAVFACENGCOM projects or when specifically directed.

****

Equipment shall be disassembled to extent necessary to provide access to spray a special finish on the coil and fins Exterior bare metal surfaces of equipment shall also be provided with this special finish. Application shall be by experienced applicators, at the premises of a company specializing in such work, using an airless fog nozzle. At least two passes shall be made with the nozzle over the surfaces to be painted for each coat. Materials to be applied are as follows:

2.10.2.1 Mild Steel Surfaces

Self-curing, zinc filled, inorganic coating with 80, plus or minus 2 percent solids content by weight minimum: one coat, 0.076 mm

Lower temperature curing Epoxy-Polyamide, high build coating with 58, plus or minus 2 percent solids content by volume of mixture components: 2 coats, minimum 0.127 mm per coat

2.10.2.2 Non-Ferrous and Heat Exchanger Finned Surfaces

Total dry film thickness, 0.165 mm maximum

Vinyl primer 24, plus or minus 2 percent solids content by volume: one coat, approximately 0.051 mm thickness

Vinyl copolymer 30, plus or minus 2 percent solids content by volume: one coat, approximately 0.102 mm thickness

2.10.2.3 Galvanized Surfaces

Modified vinyl primer, rust inhibiting with 24, plus or minus 2 percent solids content by volume: 2 coats, approximately 0.051 mm thickness

Vinyl copolymer 30, plus or minus 2 percent solids content by volume: 2 coats, approximately 0.102 mm thickness

2.11 FINISHES

Steel surfaces of equipment including reciprocating, helical rotary, scroll, air cooled water chillers, and air-cooled, remote-type condensers, that do not have a zinc coating conforming to UNI EN 10240, or a duplex coating of zinc and paint, shall be provided with a factory applied coating or paint system. Thickness of coating or paint system on the actual equipment shall be identical to that on the salt-spray test specimens with respect to materials, conditions of application, and dry film thickness.

2.12 SOURCE QUALITY CONTROL

2.12.1 Salt-Spray Tests

Factory-applied coating or paint system on equipment located outdoors including reciprocating, helical rotary, scroll, air-cooled water chillers, and air-cooled remote-type condensers, shall be factory salt-spray tested in accordance with UNI ISO 9227. Period of test shall be 500 hours. Upon completion of exposure, coating or paint system shall be evaluated and rated in accordance with procedures of UNI ISO 9227. Rating of failure at the scribe mark shall be not less than six (average creepage not greater than 3 mm). Rating of the unscribed area shall not be less than 10 (no failure).

PART 3 EXECUTION

3.1 INSTALLATION

Installation procedures shall conform to C.M. 35, and manufacturer's recommendations. Refrigerant safety relief devices shall have discharge piped to building exterior. Interlock compressor operation with the chilled [and condenser] water pump starters, so that compressors cannot operate unless the pumps are operating. Make piping connections to equipment after piping systems have been tested and cleaned.

3.2 FOUNDATIONS

Foundations for mounting of equipment, accessories, appurtenances, piping, and controls shall be provided, including supports, vibration isolators, stands, guides, anchors, clamps, and brackets. Anchor bolts and sleeves shall be set using templates. Anchor bolts shall be provided with welded-on plates on the head end embedded in the concrete. Equipment bases shall be leveled, using jacks or steel wedges, and grouted in using a nonshrinking type of grouting mortar. Foundations shall conform to manufacturer's recommendations.

3.3 LOCATIONS AND CLEARANCES

Equipment shall be located so that working space is available for necessary servicing such as shaft removal, disassembling compressor cylinders and pistons, replacing or adjusting drives, motors, or shaft seals, access to water heads and valves of shell and tube equipment, tube cleaning or replacement, access to automatic controls, refrigerant charging, lubrication, oil draining and working clearance under overhead lines. Provide manufacturer's recommended clearances for installation, operation, and maintenance, for cooling towers and chillers located within enclosures.

3.4 IDENTIFICATION TAGS AND PLATES

Provide equipment with tags numbered and stamped for their use. Plates and tags shall be brass or nonferrous material. Minimum letter and numeral sizes shall be 3 mm high.

3.5 FIELD QUALITY CONTROL

Perform tests and provide labor, materials, and equipment required. Notify the Contracting Officer, in writing, 10 days before performing tests. Tests shall be performed in the presence of a manufacturer's representative. Tests shall conform to Section 15950, "HVAC Testing/Adjusting/Balancing."

3.5.1 Start-Up and Initial Operational Tests

Provide chemicals and place water treatment systems in operation before initial start-up. Equipment shall be started and operated. Follow manufacturer's procedures and place systems under all modes of operation. Initial charges of refrigerant lubricating oil shall be supplemented to ensure maximum operating capacity. Safety and automatic control instruments shall be adjusted. Record manufacturer's recommended readings hourly. Operational tests shall cover a period of not less than [_____] days.

3.5.2 Laboratory Tests of Field-Assembled Cooling Towers

****
NOTE: If field-assembled cooling towers are not specified, delete these paragraphs.
****

Cooling towers shall be tested by a testing laboratory, in accordance with UNI 8774/FA-1. Prior to commencing tests, testing laboratory shall have been approved by Contracting Officer.

3.5.2.1 Air Temperatures

Take air temperatures by mechanically aspirated psychrometers, and in accordance with D.P.R. 412. Temperatures shall be used as ambient conditions.

3.5.2.2 Thermometers

Provide to read air and water temperatures simultaneously. Immediately prior to tests, calibrate thermometers by simultaneous immersion in hot well, or other mutually agreed upon method, and note correction factors and points of utilization for each thermometer together with its serial number.

3.5.2.3 Laboratory Test Results

Submit computations together with six complete sets of test results. Computations and test results shall be presented in full compliance with particular test procedure employed by testing agency.

3.5.3 Cooling Tower Water Treatment Tests

Conduct performance tests to determine required capacity and performance of chemical feed machinery. Determine and record the following:

a. Raw water total hardness, ppm;

b. Concentration cycles;

c. Chemical solution used;

d. Quantity of chemical solution injected into system per cycle;

e. Make-up water required; and

f. Waste to drain requirement.

3.5.4 Manufacturer's Field Services

Furnish manufacturer's representatives who are directly employed by the equipment manufacturers and trained to perform the services specified. The manufacturer's representatives shall furnish advice and services on the following matters:

a. Erection, alignment, testing and dehydrating;

b. Testing hermetic equipment under pressure for leaks, and evacuation and dehydration of machine to one degree C wet bulb or an absolute pressure of not over 690 Pa;

c. Charging equipment with refrigerant and oil; and

d. Starting equipment and training Government personnel on equipment care, operation, and maintenance.

-- End of Section --